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ABSTRACT

This report discusses SIGI, an operational example of a computer-based career guidance system. The system demonstrates that such a service can be performed well and at a cost within the reach of most schools. Data collected during the pilot trail indicate that students who had used SIGI were more aware of the career options open to them and the costs and risks associated with these options than students who had not used the system. SIGI is viewed not merely as a demonstration of computer-aided education, but more as a demonstration of how technology can be used to give students more control over their lives. The author sees the important feature of the system as its ability to respect the student's capacity to direct his own life and make his own decisions. (Author/PC)

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RESEARCH MEMORANDUM

SIGI: AN OPERATIONAL EXAMPLE OF COMPUTER-BASED CAREER GUIDANCE

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SIGI: An Operational Example of Computer-Based Career Guidance

SIGI — the System for Interactive Guidance and Information — has been under development at Educational Testing Service since 1968, with support from the Carnegie Corporation of New York and the National Science Foundation. Briefly, SIGI is a computer-based interactive program which leads students, in the space of three or four hours, through an exploration of their own career values and the values likely to be satisfied by various occupations, answers their questions about various occupations, helps them estimate their chances of success in preparing for various occupations, and then helps them plan their preparation for specific careers.

The current program is written for students in junior colleges--a level at which good career guidance is badly needed but seldom available. With some modifications, however, SIGI would be applicable to high school students, students in four-year colleges, and even adults considering a change in careers.

During 1972-73 a modest pilot field trial was run at a local junior college using a single-terminal version of the SIGI program. A more extensive field trial is scheduled for 1974-75 using multiple-terminal systems in a number of schools across the country. We expect SIGI to be available for general use beginning with the 1975-76 academic year.

SIGI owes its inception to the meeting of two ideas--Martin Katz's ideas on guidance and my own on appropriate applications of computer technology. These ideas have left their stamp on SIGI, and it will be helpful in understanding the system to lay out explicitly some of the underlying philosophy.

Guidance Philosophy

To see Katz's position on career guidance in perspective, one must first realize that the prevailing view of the role of career guidance counselors over the past four decades has been that of measuring students' abilities and finding jobs that fit those abilities--the "trait and factor" approach. Over the years a considerable technology has grown up around the measurement process, so that we now have a substantial array of guidance tests, surveys, and inventories, and sophisticated psychometric models with which to interpret the results.

Although this approach has considerable common-sense appeal, it fails by and large to take into account the student's own values. It is predicated on the assumption that what we can do well, we would enjoy doing for the rest of our lives, and this isn't always so.

A second major difficulty in the "trait and factor" approach is the implicit assumption that there is a "best" occupation for each of us, and that all one needs are sufficiently precise and reliable measures in order to perceive which occupation provides the optimal fit to our abilities. In fact, of course, there is no more a single "best" occupation for us than a single "best" spouse, decades of romantic literature not withstanding. Most people are capable of pursuing satisfying careers in a wide range of areas, and, in fact, many do so.

A third problem with traditional guidance practice is that it is oriented toward finding a suitable occupation for a student, rather

than teaching the student to find a career for himself. It thus fails to recognize that career choice is an ongoing lifetime process, that there will, in fact, be many career choices in an individual's working years, and that most of these choices will have to be faced by the individual alone, without the help of counselors and the traditional tools of counseling.

The guidance model embodied in SIGI makes very different assumptions; it assumes that the task of guidance is not to make wise decisions for students, but rather to teach students to make decisions wisely. Because life is uncertain, and because one must make career decisions with incomplete information, the wisdom of a given decision can only be judged in retrospect, months or years later. Under these circumstances the rational approach is to make the best decision possible, given the information at hand, but not to look on that decision as irrevocable. Rather it is a hypothesis to be tested, and can always be abandoned for another--at some cost--if the feedback suggests it should be.

Another distinctive feature of SIGI is that it emphasizes values first, and ability second. We are concerned to help a student find an occupation that will be satisfying, not just one he can succeed in. Of course these are not really independent--people are more likely to succeed in work they enjoy. Ability is not ignored; students need whatever information they can get on their chances of success in an occupation--or rather, their chances of success in the training program for an occupation. In SIGI, however, such predictions are given only after SIGI

has suggested a list of possible occupations selected on the basis of the student's values. Moreover, predictions of success are only given as information. We leave it to the student to decide whether or not to attempt a training program which may be difficult for him.

System Philosophy

A central feature of our system design has been the requirement that SIGI be a tool for the student, rather than a simulated counselor. We have avoided any attempt to make the system appear sentient by "personalizing" messages with the student's name, allowing natural-language inputs, or the like. For our purposes such features would add unnecessary overhead and would detract from our attempts to help the student see the system as a resource entirely under his direction and control.

The organization of the SIGI program reflects this philosophy in many other ways. Students are directed once through the entire system in a fixed sequence to familiarize them with what is available; after that initial experience they are free to use any portions they choose, whenever and however often they wish. Users familiar with the system can, at their option, bypass much of the explanatory material that they have previously seen. At other points students are free to ask the system for more detailed explanations than most users will need.

A second requirement that we have imposed on the SIGI system design is that it be "lean," a system in which every component pulls its weight and justifies its cost. It has been our intention to pro-

duce a system within the financial reach of almost every school. This has not led us to the cheapest system--for example, teletypes would be less expensive than the CRT terminals that we use--but it has led us to reject such features as audio, photographic image projection, and graphic capability on the CRT terminal--features which would have been useful, but not useful enough to justify the added costs. An early version of SIGI did in fact incorporate an image projection device as part of a custom-built dual screen (CRT plus image device) student terminal, but it quickly became apparent that we would have to use standard, commercially-available equipment if SIGI costs were to be kept reasonably low.

On the other hand we have chosen to carry the added costs of some features where we felt that they significantly improved SIGI. For the substantial amount of text that needs to be presented in SIGI, and for the sense of interaction we are seeking to give the user it seems to us that only a device capable of writing at about 100 characters per second or faster is acceptable. Hence we use CRT displays rather than teletypes. Even here we have insisted on features such as better-than-average display quality, upper- and lowercase character sets, and a 2000-character screen capacity. Our experience suggests that these features improve SIGI enough to justify their cost.

An important step in the system design was the decision to build SIGI on a small, stand-alone minicomputer hardware configuration, rather than on a full-sized processor. Several considerations influenced this choice. One was the observation that SIGI is essentially a character-handling program, primarily moving text from disk to terminal, sometimes

modifying it in the process. For such tasks as these, processors with large word lengths and extensive arithmetic instruction sets have no particular advantage.

A more important consideration was "transportability" of the system. On this issue one's first instinct would be--most likely--to build SIGI for the larger computers already installed in many schools. While it is true that many schools already have processors, and that one manufacturer accounts for better than 80% of the processors installed, such figures are deceptive. In fact the range of processor models, configurations, and operating systems in use in junior colleges is so great that we were unable to identify any single large system on which SIGI could be offered to a very significant number of schools. Moreover, most computers in use in junior colleges are used as batch processors, and are ill-equipped to support simultaneous real-time programs. The cost of upgrading the hardware alone in such systems to provide such support often approaches or exceeds the outright purchase cost of a typical stand-alone minicomputer system. Couple this with the fact that it is substantially more difficult to operate and support a large time-sharing system, so that schools would have to make additional investments in training and recruiting, and the economics of a large-processor version of SIGI look fairly unattractive.

Given these conditions we have chosen to make SIGI software "transportable" by packaging it with its own dedicated hardware--a PDP-11/40 processor at present, although many other minicomputers would serve. We have been relying on the continued development of more sophisticated

and less expensive minicomputers, and so far the trends look very favorable. At present we are aiming primarily at systems with 4-16 terminals served by one processor, at a hardware cost, including maintenance and depreciation, in the neighborhood of $2 to $3 per student hour.

Hardware Configuration

The current version of SIGI has been programmed in MACRO-11 for operation on a Digital Equipment Corporation PDP-11/20 processor with 28k of core memory and 2.4 million characters of disk storage. This configuration supported a single Delta Data Model G CRT terminal in our recently completed preliminary field trial.

We are presently engaged, with Digital Equipment Corporation, in rewriting SIGI for operation on a PDP-11/40 or 11/45 under RSTS/E--Resource Sharing Time Sharing System/Extended--a multi-terminal, multi-task, BASIC-language operating system supported by DED. A minimal system, consisting principally of a PDP-11/40 processor with 48k of core memory and 7.2 million characters of disk storage, will support upwards of four terminals. This system is scheduled for completion and installation at five trial sites by the end of this year.

For the student terminal we are presently using Delta Data Model G CRT display and keyboards, which have a 2000-character display capacity on a 27 line by 80 character screen. Hard copy, where required, is provided by Texas Instrument Model 733 RO thermal printers interfaced directly to each display.

The SIGI Script

We think of SIGI in terms of a "script," which reflects our experience that writing good material for interactive presentation by a computer resembles writing for the theater or TV stage more than it does writing for a book. The SIGI script is composed of five major sections: Values, Information, Prediction, Planning, and Strategy. Initially students pass through these sections in just this order, exploring their own occupational values, searching for and examining occupations that fit those values, looking at educational programs that are appropriate, making predictions of their probabilities of success in various programs, and finally integrating all this information. Once students have passed briefly through the entire sequence of sections so that they are acquainted with what SIGI offers, they are then free to use these sections in any order and for any length of time they wish. Our experience has been that students vary widely in how they use the system; some dwell on values, others explore occupations at great length, yet others will cycle many times between the occupation search and the planning program, and a few are satisfied with their first pass through the system in sequence and show no particular desire to return to any of the sections.

Values System

In the Values section, the student's attention is drawn to ten occupational values which we have determined, by various means, to be important to most people, to be relatively independent of one another,

and to differentiate between occupations. These are income, prestige, independence, the opportunity to help others, security, variety, the opportunity for leadership, leisure, early entry (which means the ability to enter the occupation with a minimum investment in additional education), and field of interest (e.g., how committed is the student to working in some primary area of interest, such as science?).

It's not enough, though, to ask students how important each of these values is to them; it is necessary to also ask them to think about trade-offs. We would all like jobs with high income and a great deal of leisure, but if we can't have both, which would we sacrifice first? In SIGI students rate each of the ten occupational values individually, on a scale of 0 to 8. After this, the script takes students through the "Values Game," a sequence in which they select simulated occupations that feature one value, and then are challenged by a succession of deficiencies in that occupation, or temptations to move to another occupation, that have the effect of forcing them to consider trade-offs between competing values. Displays at the end of each game summarize the student's choices and draw attention to any choices which are inconsistent with the manner in which the values were initially weighted.

Following a number of passes through the values game, students return to the task of weighting their values in the abstract, this time assigning weights to all ten values together to reach a fixed sum, a procedure which forces them to consider trade-offs again, as the average weighting across values must equal 4. This means that students cannot weight all values high; they must decide which values

are most important to them and which they will sacrifice if they must. The results of this final assignment of values is retained in the student's record and is used in other portions of the script, although the student is given opportunities to reconsider and reweight the values.

Information System

The information system is built around a data base of occupational information which currently includes 129 occupations, and will eventually be expanded to between 200 and 300. This information can be used in two ways: to locate all occupations that meet certain specifications or to ask questions about particular occupations.

In the "locate mode" students choose any five of the ten values SIGI uses, and then specify for each of these five values a minimum level. For example, a student might include the value "income," and might specify for that value that he or she was interested in occupations with average salaries of $11,000 or more. Once specifications have been set on all five of the values chosen, SIGI searches the occupational data base for all occupations which meet or exceed the set of specifications. If no occupations fit, students are encouraged to loosen their specifications--perhaps by accepting less income or by agreeing to more education--and try the search again. On the other hand if the list is too large (over 20 in the present script), students are required to make their specifications more strict. A student may request a print-out of any list of occupations retrieved, and SIGI stores up to 40 occupations from this search mode in the student's record for later use.

The second manner in which the information system operates is in the "compare mode." This portion of the system allows the student to select occupations three at a time--either from the list of occupations found in the locate mode or from the entire list of available occupations--and to retrieve specific information on each occupation, such as the amount of education required, beginning and average wages, the employment outlook, and the like. We currently store answers to 28 such questions about each occupation.

Prediction System

The purpose of the prediction system is to give students some idea of how much difficulty they may encounter in various programs of study. For this purpose schools are asked to identify their major programs of study--such as nursing, law enforcement, general business, data processing, etc.--and then to identify for each program a "key course." The key course for a program is that course--usually an introductory one--which typically separates those who will do well in the whole program from those who won't. On request SIGI will produce for the student a prediction for any key course, displayed in terms of the chances per 100, for students with similar achievement, of receiving a grade of A or B, of receiving a grade of C, and of receiving less than a C grade.

In our initial field trial test scores were available for students from the Comparative Guidance and Placement Program (CGP) administered by Educational Testing Service, and so these scores, together with high school rank in class, were used in regression equations developed for each program of study at our test school to produce the predictions.

The revision of SIGI currently being produced will continue to make use of test scores--from our own CGP testing programs or any other testing program with adequate validity--if they are available. However, a substantial number of junior college students do not have recent test scores available, for one reason or another, and so we are experimenting with the use of "informed self-estimates" as an alternative means of producing predictions. A self-estimate is an estimate elicited from the student as to how well he thinks he might do in various courses; an informed self-estimate is one elicited after SIGI has shown the student the requirements and activities that characterize each key course and the distribution of grades obtained by previous students, along with a number of other descriptive variables. Tentative results from a study just completed suggest that estimates produced in this manner are as valid as those produced with test scores--that is, students are pretty good at estimating how well they are likely to do in a given course if we give them enough information about that course.

The prediction system builds a table of these predictions of success, a ing each program a student requests and finally producing a print-out for the student to take with him.

Planning System

The purpose of the planning system is to lead the student through the steps necessary to plan for entry into a particular occupation. It consists of an interaction which helps a student choose a program of study, if there is more than one program that leads to the occupation of interest, and then displays a recommended sequence of courses--both required and

elective--for the program. It also provides information about colleges in the region that offer programs for each occupation. In addition the planning system draws the student's attention to prerequisites which may need to be fulfilled to enter the program of interest, and it includes a fairly lengthy list of sources for financial aid which a student may retrieve and produce in hard-copy form.

This section, like the prediction section, is tailored to each school. In effect, SIGI carries in its storage most of the information that is contained in the school catalog. In preparing to install SIGI, the counseling staff of a school must specify one or more recommended programs for each of SIGI's occupations, and then a recommended sequence of courses for each program. If a school does not offer a program of study for a particular occupation, SIGI will display a list of some of the schools within a reasonable distance that do offer such preparation.

Strategy System

The final section in SIGI--Strategy--helps the student to integrate the information that the previous form sections have presented. If a student has already settled firmly on a single occupation then strategy will add little. Many students arrive at this point in SIGI with several possible occupations in mind, and need to weigh the gains and losses for each one. Strategy helps in this process by computing an index for each occupation that takes into account both the degree to which that occupation fits the student's values and the likelihood that he or she will succeed in the program of study appropriate for that occupation. Strategy takes

any three occupations in the SIGI data base which a student chooses and computes a "desirability sum" for each. This is computed by multiplying the student's weighting of each value by the rating of the occupation on that value, and then summing these products over the ten values. The higher the sum, the closer that occupation matches the values profile provided by the student.

Having accounted for desirability, SIGI now accounts for probability of success by multiplying the desirability sum for each occupation by an estimate of the student's probability of completing the necessary preparation for that occupation. This produces the final index, which can be used as a rough comparison between occupations. It helps students to consider the trade-offs between the desirability of some occupations and the likely difficulty in preparing successfully for them.

Summary

SIGI is an operational example of a computer-based career guidance system; it is a demonstration that such a service can be performed--and performed well--at a cost within the reach of most schools. The great majority of the students who have used SIGI have felt that the experience was helpful and worthwhile. It will be a few years yet before the long-term effects of SIGI can be assessed, but data collected during our pilot field trial indicate that students who have used SIGI are more aware of the options open to them, and the costs and risks associated with these options, than students who have not used SIGI.

We feel that SIGI is more than just a demonstration of computer-aided education; however, it is a demonstration of how technology can

be used to give students more control over their lives, rather than less. The important feature of SIGI isn't the information in the data base, and it isn't the sophisticated hardware and software developed to deliver that information. The important feature of SIGI is that it respects the student's ability to direct his own life and make his own decisions, and encourages him to do so.